

EBS 125 Lab 4: Comsol Modeling

Lab report due May 12th, before class

Objectives:

1. Model symmetry conditions for both steady state and transient conditions

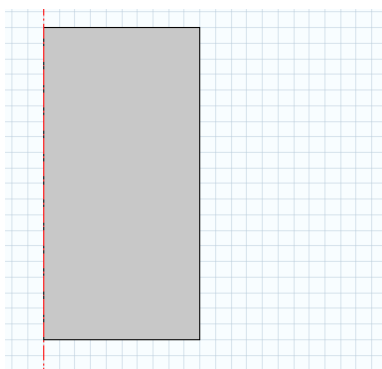
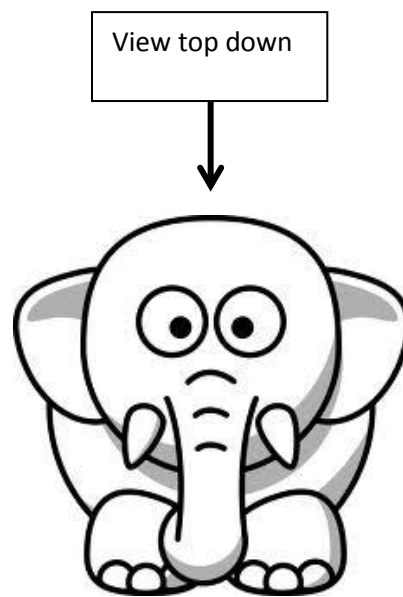
Materials:

1. Comsol Multiphysics

Procedures:

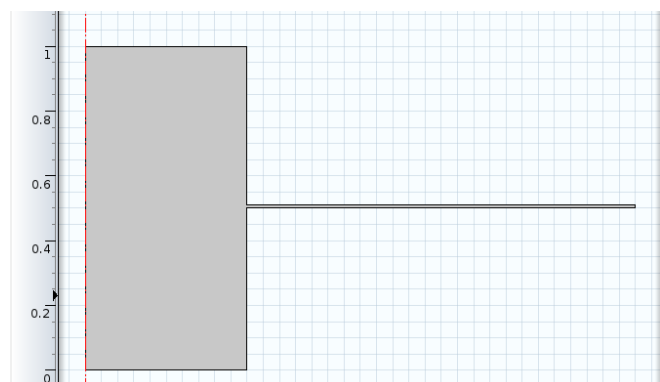
Please see lab report section for a complete list of data you need to collect for the lab.

1. Elephant problem:



No ear

VS.

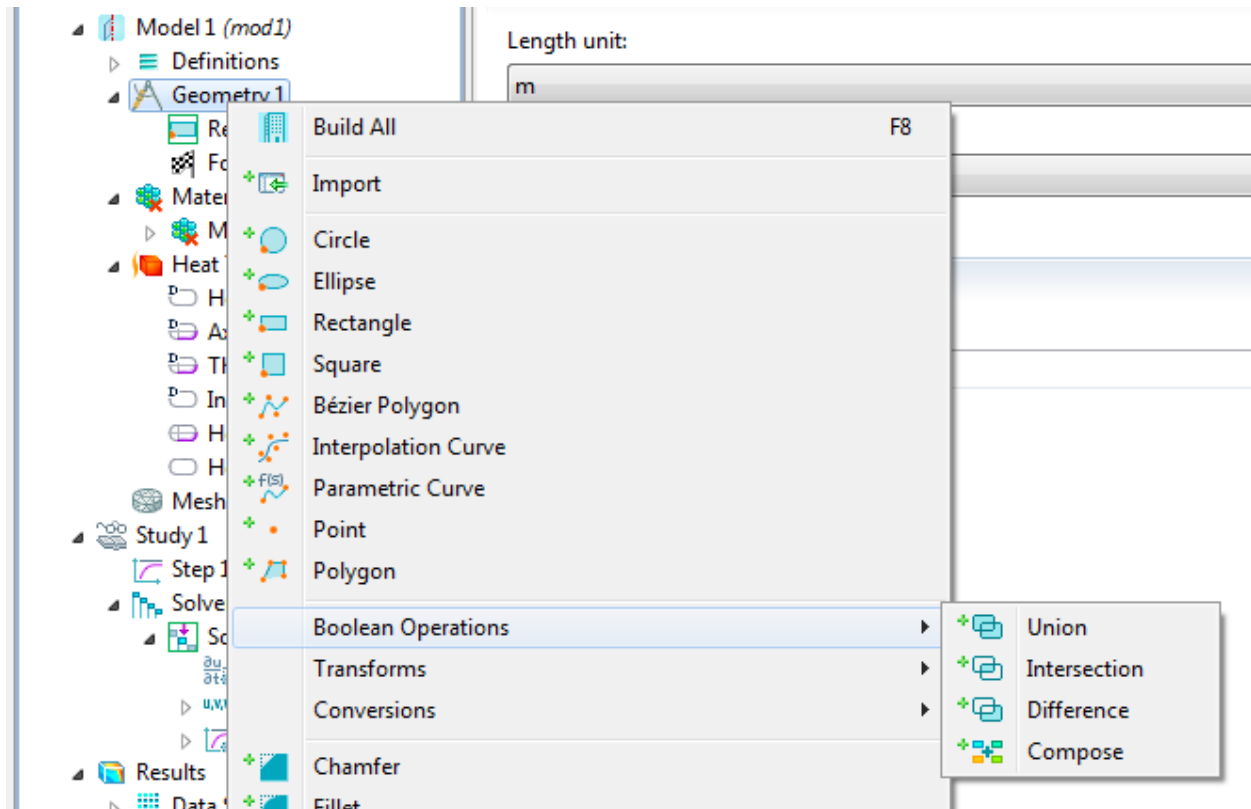


with ear

Modeled as 2D- axisymmetric:

- a. Geometry
 - i. Head: 1x1m square
 - ii. Ear:
 - 1. Thickness: 1cm
 - 2. Width: 1.2m

Use Boolean operations -> Union to unify the head and the ear to one object



- b. Materials
 - $K = 1.4 \text{ W/m K}$
- c. Boundary conditions
 - i. use symmetry condition through 2D axisymmetric geometry
 - ii. Flux condition at the top and side ($h=7 \text{ W/m}^2\text{K}$, $T_{\infty} = 35^{\circ}\text{C}$,)
 - iii. Heat generation:
 - i. $Q = 60 \text{ W/m}^3$
- ci. Mesh
 - i. Free Triangle, fine

2. Spherical Object Cooling Problem

To set up the simulation, choose 2-D axisymmetric geometry heat transfer in solids, and transient options.

1. Geometry
 - a. Sphere, $r = 60 \text{ cm}$
 - i. To build a sphere, right click on geometry and select circle,
 - ii. Type in $r=0.6\text{m}$
 - b. Center at (0,0)
2. Material
 - a. Object A
 - i. $k= 25 \text{ W/m K}$, $\rho= 950\text{kg/m}^3$, $c_p = 4000 \text{ J/kg K}$
 - b. Object B
 - i. $k= 500 \text{ W/m K}$, $\rho= 950\text{kg/m}^3$, $c_p = 4000 \text{ J/kg K}$
3. Initial Condition
 - a. $T=100^\circ\text{C}$
4. Boundary Conditions
 - a. Heat flux on the surface ($h=50\text{W/m}^2\text{K}$, $T_\infty=4^\circ\text{C}$,)
5. Mesh
 - a. Build Mesh
6. In the Model Builder window, expand the Study 1 node, then click Step 1: Time Dependent.
In the Settings window for Time Dependent
In the Time field, choose h
In the Times text field, type range(0,1,10).
7. On the Home toolbar, click Compute.

Lab Report:

No introduction nor material and method session are needed.

In the results session:

1. For the elephant problem.
 - a. Solve for the temperature profile using Comsol (stationary) twice: one with the fin, one without the fin.

- b. Does a single fin help with this modeled elephant?

Answer with showing the temperature vs. location graph along the same center line for both cases (the center line for the with fin case is 1.7 meter long, while the case without fin is 0.5 meter long)

2. For the spherical object cooling problem:

- a. Compute how temperatures on the surface and in the center vary with time (10 hours) for both objects ($k=5 \text{ W/m K}$ and $k=500 \text{ W/m K}$).
- b. Plot the temperature vs time graph for these two points for both the cases in Excel.
- c. Calculate how temperature on the surface and in the center vary with time for the object B ($k=500 \text{ W/m K}$) analytically. Compare the analytical solution with numerical solution (Plot the graphs in excel or Matlab).
- d. Plot how temperatures vary with location (R) for these two cases for all times, explain your results (do a cut line 2D, and plot temperature distribution for all times. Comsol graphs are good enough, no need to export graph to excel).